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# HARD-FACINGS

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This is about hard-facing—its past, present, and some indication of its future.

Early experiments at the beginning of this century were directed toward the development of non-tarnishing, stainless alloy for use in the manufacture of cutlery. These experiments involved primarily the alloying of cobalt and chromium, but it was found that the addition of tungsten produced a material of such hardness that no ordinary tool steel could cut it. Several years of experimentation on various compositions of cobalt, chromium, and tungsten developed the alloy now commercially called "Haynes Stellite." The name Stellite was coined from the Latin "Stella," which means a star, as indicative of its brilliant, silvery lustre; Haynes Stellite is in honor of Elwood Haynes the developer of this alloy. Haynes Stellite was first used as a cutting tool in the Haynes automobile plant, and in 1913 this new cutting tool was placed on the market.

Haynes Stellite alloy possesses several unique properties which make it especially adapted to cutting tool requirements. It is usually thought that this alloy is extremely hard, but when measured at room temperature its hardness is actually slightly less than that of hardened high speed steel. However, at elevated temperates, Stellite retains much or its original hardness. This property which is known as "red hardness," is one of the most essential features of a superior cutting tool. The reason for the high degree of red hardness of Haynes Stellite is easily explained. All hardened steels soften at elevated temperatures because the iron content, at red heat, has the property of dissolving the hardening constituents. Stellite is non-ferrous; the cobalt which is used as a base does not dissolve the hardening constituents until the alloy is heated almost to its melting point.

The fact that cutting operations generate heat is well known, but the instantaneous temperatures reached due to friction are much higher than would be expected. Although there may be no visible evidence of the heat generated due to dissipation into the body of the metal and into the air, cutting edges often approach red heat. Determinations by E. G. Herbert, independent English investigator, and O. W. Boston show cutting edge temperatures for very average conditions to run as high as 1000 deg. F. Based on this data it is estimated that under commercial conditions edge temperatures of cutting tools reach 1300 deg. F. To give satisfactory service under these temperatures a cutting metal must remain hard at the high temperatures developed—thus the importance of red hardness.

The manufacturer of facing material also point to their alloys' low coefficient of friction and to their tendency to take a high polish. These characteristics lessen the amount of heat generated by friction between contacting parts. The reduction of friction not only increases the life of the alloy surface but it also lessens the wear on other metals working in contact with it. For example, it was necessary to replace a certain steel shaft every week, and the bearing in which it turned every two weeks. Hard-facing the shaft not only increased its life but also increased the life of the unhard-faced bearing five times.

The technique of hard-facing has come about as the natural outcome of a search for new processes whereby the unique properties of Stellite could be used to advantage. Hard-facing might be defined as the process of welding a coating of wear resisting alloy to the wearing surface of a metal part. In the majority of cases the thickness of the alloy deposited ranges from 1/16 to ¼ inches. Naturally when an alloy is applied as a thin layer it must possess certain properties in common with the base metal to facilitate adherence. In the first place, the alloy must be able to resist the high temperatures of welding without oxidization. The melting point of the alloy should be slightly less than that of the base metal, usually steel. To prevent cracking during cooling the applied surface must possess a coefficient of expansion close to that of the metal to which it is applied. Needless to say, the ease with which the facing can be applied is also an important consideration.

Hard-facing may be divided into three general classes—(1) metals having an iron base and containing hardening elements such as chromium, tungsten, manganese, or silicon, (2) non-ferrous alloys, and (3) the so-called diamond substitutes which are essentially tungsten carbide. Hard facing materials of the first class are used only under conditions of moderate wear or severe impact. This group makes an excellent "filler rod" for rebuilding badly worn parts where service involves considerable heavy impact rather than scour. As they are usually quite tough and rather ductile they serve well as a base material over which is placed a final harder layer.

The second group, the non-ferrous alloys, is represented exclusively by the Haynes Stellite alloys. Due to the wide range of uses for these alloys Stellite rod is marketed in three grades—No. 1, No. 12, No. 6—listed in the order of their decreasing hardness. No. 1 is the most resistant to abrasion but is also the most likely to check or chip under shock. No. 12 is slightly softer, less resistant to abrasion, but is much stronger and somewhat more ductile. The No. 6 grade, softest of the three, is specified for work subjected to heavy shock or impact such as hot shearing or blanking dies. All three grades of Stellite alloys are finished by grinding.

The diamond substitutes, group three, are of such hardness that they cannot be applied by melting. They are therefore used in the form of small castings of uniform shape and size which are held in place by a binding material. The binding material is often one of the group one alloys or a material especially made for use with the diamond substitute. Diamond substitutes are finding much favor in the drilling of oil wells.

Hard-facing alloys are applied to the base metal by a method similar to brazing. The oxy-acetylene flame used in hard-facing must contain an excess of acetylene—a "reducing" flame. When facing is applied to steel, as is usually the case, the base metal is not melted, but is brought to a "sweating" heat. If the facing material is applied when the base is in this state actual fusion does not take place but a strong bond is formed between the surface layer and the base. Fusion is not desired as it would introduce iron in the facing alloy and reduce its red hardness.

Hard-facing rods can be applied by either oxy-acetylene or the electric arc process, although the former is recommended since dilution of the hard-facing deposit with iron from the base metal can be held to a minimum. When the electric arc process is used the polarity should be reversed, making the rod the positive electrode. Bare electrodes can be used, but flux-coated rods flow better and make smoother deposits.

Of primary importance in the reduction of cost is the longer life of hard-faced parts. As a direct result of increased life, however, fewer replacements are necessary. In many cases replacement of worn parts results not only in a loss of production because the equipment must be shut down while the replacement is being made, but also in a loss due to idle labor during replacement. A further saving, which in many instances is of considerable importance, lies in the fact that if hard-facing is employed, the metal for the part itself can be selected primarily for its ability to withstand shock and fatigue without regard to wear resistance.

Because of the economies of hard-facing it has become widely used in the construction industry, particularly in excavating, the automotive industry for valve seat inserts, the cement industry for grinding rings, in agriculture for plow share edges, in the iron and steel industry for shear blades, and a rapidly increasing list of others too numerous to mention.